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ETHNOLOGY.—*The modern growth of the totem pole on the Northwest Coast.*[1] MARIUS BARBEAU, Dominion Ethnologist, National Museum, Ottawa, Canada. (Communicated by H. B. HUMPHREY.)

Totem poles were once a characteristic form of plastic art among the tribes of the Northwest Coast, in British Columbia and southern Alaska. The natives took pride in them and strained every nerve to make them worthy symbols of their own social standing and achievements.

But the carvers were not artists in our present acception of the term; they were not permitted to give free rein to their imagination or fancy. They had little or nothing to do with the choice of the cedar tree they were to carve, nor the spot in the village where it was to be erected after it was carved, nor even the selection or the number of the figures they were hired to execute. Their art was not considered aesthetic; it was useful. Regulated by custom, it fulfilled a social purpose and was the chief vehicle of a system of heraldry which in a short time grew to abnormal proportions. Hence its vital importance in the life of the natives.

The totems, what they were.—The totems whose figures appear on the poles were not, as often misrepresented, pagan gods or fetishes, nor did they stand for clan ancestors. Their spiritual significance was quite secondary; they were not worshipped or even revered for their own sake. First of all they were symbols in the nature of European coat-of-arms or badges of ownership, and they usually illustrated historic events either true or fictitious.

When a new totemic emblem was introduced—this happened only seldom—an explanation of its origin and significance was usually furnished; this was purely stereotyped. The people were not credulous enough to believe their own tales, nor presumably the other folk at large.

The Raven, the Wolf, the Eagle and the Thunderbird were four

[1] Address before the Washington Academy of Sciences, delivered April 21, 1938. Received June 27, 1938.

of the outstanding totems of the Northwest Coast. They were used in most places from Alaska to the Strait of Georgia. Yet hardly any effort was made to explain how they had become the exclusive badges of definite families. They were hereditary and taken for granted. Nor was a Raven or a Wolf god supposed to exist in that country. At best the Raven was a culture hero of ancient folk tales, quite apart from heraldry. And I wonder whether the Eagle emblem, admittedly recent, is not a mere imitation of the Russian imperial crest. Like it, it often appears as a double-headed eagle, and it originated in the country occupied by the Russians, about the time of their occupation.

When a stereotyped explanation is given of the origin of an emblem it runs like this:

> A man named Small-frogs long ago was starving with his family, up the Nass. As he stood at the edge of the lake, a monster emerged from the water —Large-eyes, with a huge human face. Assisted by his human family, he cut this being in half and succeeded in pulling the outer part of its body out of the water. Later he gave a feast to the people, and adopted Large-eyes as an emblem. It was represented pictorially with a large human face and a body without legs—just a trunk.

A story of this kind was of little importance to the people. What mattered was the feast given and the presents distributed to confer prestige upon the emblem which was supposed to illustrate it. Without this consecration no emblem ever came into existence, for it would have had no status, no social recognition. It would have been an object of ridicule.

The figures or totems most commonly used, besides the above-mentioned, were those of familiar animals: the Frog, the Killer-whale, the Bear, the Owl, the Halibut and the Starfish. A number of other themes, localized, were derived from the fauna, the flora and the traditions of the country. Such phenomena as the Rainbow, the Stars, the Earthquake, the Glacier, casually appeared in the list of clan and personal badges. Among them we find even the White-man's dog, the Palisade and the Waggon-road.

The totem poles, where and how they stood.—There were carved house poles and totem poles proper, detached, that stood in front of the houses. Smaller poles with grave-boxes were also found among some of the tribes, mostly in the southern districts. House-front paintings, carved house-posts and graveyard structures were more ancient than detached poles. The detached totem poles as a fashion were fairly recent.

The village houses almost always stood in a row along the water

FIG. 1.—The row of totem poles at Kitwanga, on the upper Skeena river. This village on the Canadian National Railway line to Prince Rupert is often visited by tourists in the summer. FIG. 2.—The Salmon pole of Angeedaw, now at the Royal Scottish Museum, Edinburgh, Scotland; one of the finest poles of the Nass river type.

front, quite close to the edge of the water, either in the coves or along the rivers. The Tsimsyan were the only people of the true West Coast nations whose habitat consisted of rivers as well as of the adjacent sea coast. The villages of two of their sub-nations (the Niskae and the Gitksan) dotted the whole length of two rivers—the Nass and the Skeena, close to the Alaskan boundary. It is only there that we find totem poles away from the coast, up the rivers, as far as two hundred miles away from the tide-waters.

The detached poles stood in a row, in front of the owners' houses —a few feet away, and quite close to the waterfront. They extended

the whole length of the village, in an impressive, though irregular, row of tall carved columns sometimes surmounted by detached figures of birds, animals and people.

Totem poles until recently stood along the village fronts of only a few nations in the north: the Haidas of Queen Charlotte Islands, the Nass River people and the southern Tlingit, of Alaska. Elsewhere

FIG. 3.—Totem poles at Skidegate, Queen Charlotte Islands.

they were either non-existent or very few. The only way of showing the owner's crests, when this was done, was by means of painted designs on the house fronts, or a few carved portals.

A pole was left to stand as many years as nature would permit. Sometimes two or three poles belonged to the same family, but had been erected at different times as memorials to chiefs after their death, one generation apart from the other. They stood side by side, and were part of the village cluster. Some of the poles leaned to one

side, ready to fall, sometimes supported by props. It was not the custom to mend or transplant a pole, however precarious its condition. Once fallen, it was pushed aside, if it were in the way; it decayed gradually or was cut up and burnt as firewood.

The totem poles of the Haidas of the Queen Charlotte Island and of the Niskae of the Nass River, have mostly fallen and disappeared, or they have been removed to museums abroad. Some of the Tlingit poles, on the Alaskan coast, are being preserved where they stand. The only collection that is still fairly intact is that of the Gitksan tribes, on the upper Skeena River, in northern British Columbia. It consists of over one hundred poles, in isolated village groups of from a few to about thirty, in the eight tribal villages of the upper Skeena. Some of these are also being preserved by the Canadian Government and Railways.

The natives abandoned their old villages and moved to new quarters, many years ago. The old village sites are now deserted; the plank houses have fallen in, and the totem poles were forsaken in those former abodes of native life. They fall down and decay, while others lean precariously or totter in the wind, soon to come down with a crash. A few of the finest clusters, among the Tsimsyan, were wilfully destroyed in recent years. They reminded the modern villagers too much of their breech-clout ancestors whom they were anxious to deny and forget, in their haste to ape the white people.

The art of totem pole carving now wholly belongs to the past. As it is not really ancient, it has covered altogether less than a hundred years, mostly from 1840 to 1880. For the Haidas and the Niskae it came to an end about 1880. Elsewhere it actively survived till after 1900. The Gitksan near Hazelton have erected a few poor specimens in the past ten years.

The age of totem poles.—It is a mistake to say that totem poles are hundreds of years old. They could not be. A green tree, cut down, carved and planted without preservative cannot stand very long, as it is highly perishable. It rots at the base, and its weight together with the wind brings it down within a fairly definite span of years—often less than fifty years on the coast, where the moisture is intense and the muskeg foundation is corrosive. Up the rivers, where the climate is drier and the soil is sandy, some of the poles, the oldest, have stood as long as 70 or perhaps 80 years. They are the most archaic specimens of the kind. A minute examination of each one of them on the upper Skeena has made it clear that the art of totem pole carving evolved out of humble beginnings mostly after 1840. In

a short period of intensive development it passed through two or three phases or styles.

Practically all the poles of the Haidas and the Tlingit as we know

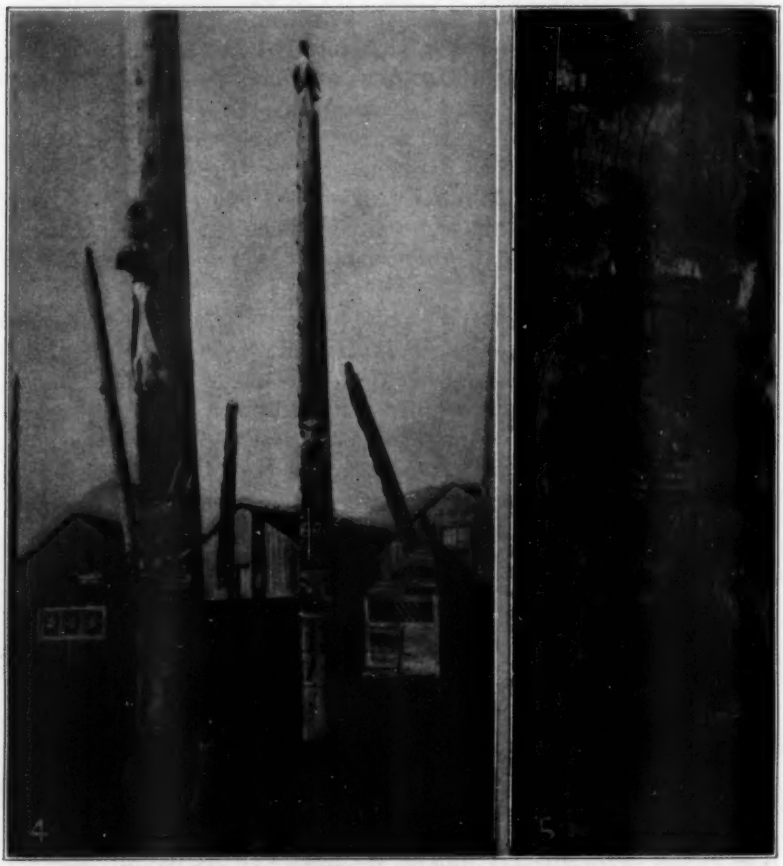


FIG. 4.—Totem poles at Gitwinklkool, a Gitksan village on the Grease trail between the Skeena and the Nass rivers. FIG. 5.—The Woman and Lizard pole of Gitlarhdamks, upper Nass, now at the Royal Ontario Museum, Toronto; a fine carving in a state of decay. It was part of a totem pole, one of the oldest.

them were carved between 1860 and 1880, at the time when the fur trade on the Northwest Coast and at Victoria was at its height and native ambition had not yet been ruined by the introduction of Christianity.

The growth of the system of native heraldry.—The growth of heraldry

on the Northwest Coast coincides with that of the art which served it as a vehicle. On the whole it can hardly be said to be very ancient or prehistoric.

Archaeologists so far have failed to unearth anything like the present totems, even in miniature form. The small stone or bone carvings and rock engravings that have been found in many places, when they are old, are of a different type—rather formless and naturistic. They have very little in common with the highly stylized art of such tribes as the Haidas, the Tsimsyan and the Tlingit.

The generation of wood-carvers that worked from 1860 to 1880 is acknowledged by the natives as the best. The names of the craftsmen have been partly compiled; their work can often be identified. They belonged almost exclusively to the Niskae, the Haida and the Southern Tlingit tribes.

One of the two best-known carvers of the Haidas, of Queen Charlotte Islands, was Edenshaw. This name is hereditary, as are the personal names. Out of three generations of Edenshaws, the second, from 1840 to 1880, was that of the best wood-carver of that name. The earliest of the three was an expert metal worker, evidently sometime after the introduction of metals by European sea traders.

The older tribes of the Tsimsyan still remember a time when their ancestors were not totemistic, had few if any emblems, and did not observe the rule of exogamic marriage, which is the outstanding feature of totemic organization. Yet the Tsimsyan are now one of the only three totemistic nations of the Coast.

If this type of social organization and its counterpart in heraldry existed at all before the coming of the Russians, at the end of the seventeenth century, no evidence can be found to prove it, whereas every indication points to its spread and development since.

The early mariners and discoverers, from 1779 to 1800, failed to observe any real detached totem poles, among the Haidas, the Tsimsyan or the Tlingit. Only a very few house posts and portals, roughly carved, crude masks and carved objects, were seen in various places and, in one village, house-front paintings. Some drawings of these were made by the visitors at the time. They are the only evidence that is left of native art at the end of the eighteenth century.

From one or two of those records, it is clear that the typical stylization of West Coast art already existed in the neighborhood of the present Alaskan frontier. But it must have been fairly restricted in scope, at the time, and also in the area of its diffusion. Was this stylization aboriginal or derivative?

It had every chance of being derivative. Yet it is difficult to say from where, for the lack of sufficient comparative data. Advanced stylization can be the result only of intense cultural development,

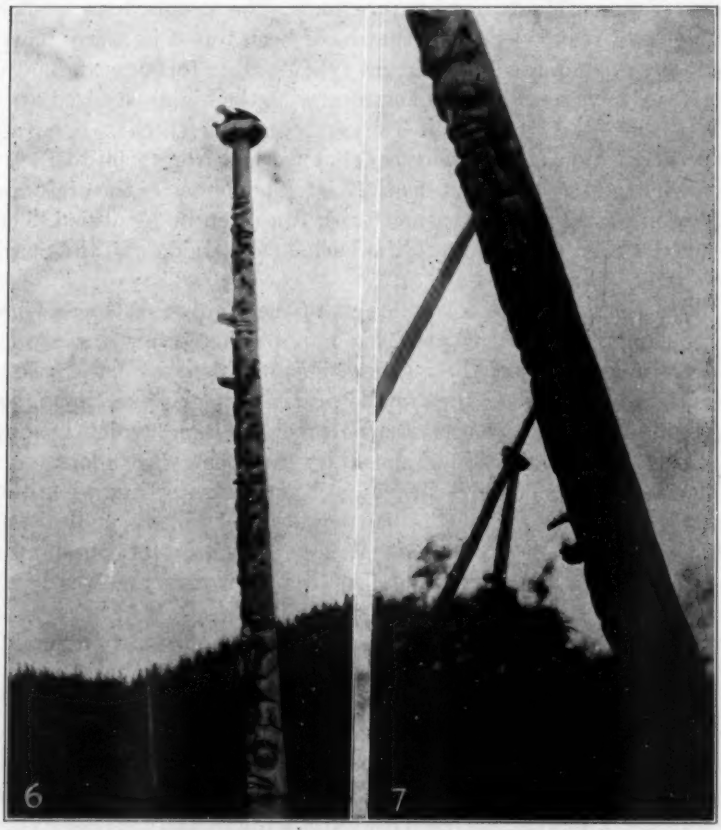


FIG. 6.—The Eagle's Nest pole, of Gitiks on the lower Nass. It now stands, sixty-six feet high, in the provincial park at Charlesbourg, near Quebec. FIG. 7.—The Mountain Eagle pole (to the right), now at the Royal Ontario Museum, Toronto. It is 81 feet high—the tallest and perhaps the finest in existence. From the lower Nass.

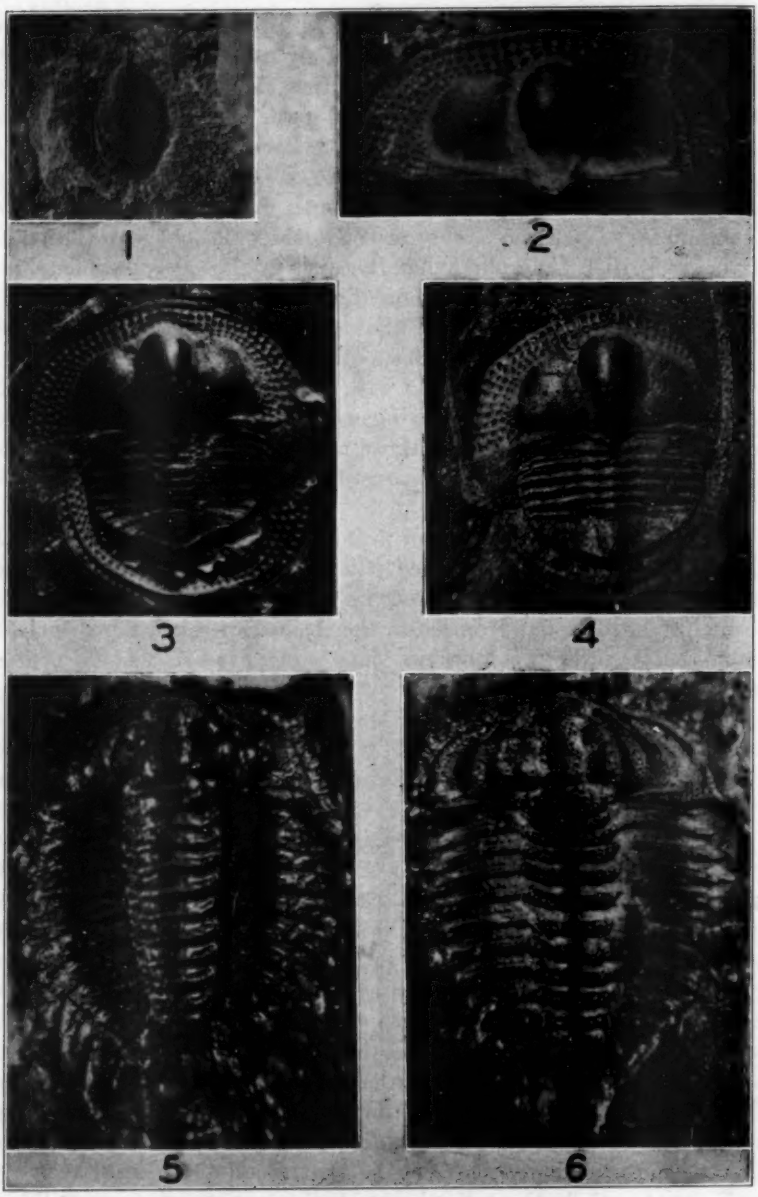
such as never had happened on the Northwest Coast in prehistoric times.

From distant resemblances, it seems that some of the Northwest Coast designs, like the culture itself, are of an Asiatic type. The use of masks is modern among the northernmost nations of the coast,

but it seems to have been common on Vancouver Island at the time of the discovery. Masks are also commonly used in Asia. The Tlingit patterns on Chilkat blankets, among other things, resemble those of the garments of the Ainus in northern Japan. The West Coast people are not the only ones at the edge of the Pacific to have erected tall carved memorials or totems. These are also known under various forms in Japan, Korea, and in the South Seas. Some of the New Zealand carved poles so closely resemble the older poles on the Nass River, in British Columbia, that the ones might easily be mistaken for the others. The technique of erecting them, besides, was identical. It is quite possible that the Kanakas of the South Seas, brought over to the British Columbia coast by the earliest circumnavigators, may have had something to do with the development of this local art in America. Indeed, the carvings of the South Seas and Asia have many points in common with those that were executed in the mid-nineteenth century on the Northwest Coast—their sea-shell incrustations in particular.

Where the detached totem poles first appeared.—It is probable that the custom of erecting detached poles as memorial columns to the dead originated among the Tsimsyan of the lower Nass River, close to the present Alaskan frontier on the coast. But if it is more ancient there than elsewhere, it does not date back very far. The old people have heard of the time when two out of three of the Tsimsyan nations had no totem poles. One of those nations along the coast in fact never quite adopted that custom, as it passed under the banner of Christianity about 1850, a decade or so before totem poles became the fashion in the north.

It is far more likely that the Haidas and the Tlingit imitated the Nass River people than the reverse. Candlefish or *ulaken* fishing made of the estuary of the Nass the most important thoroughfare of native life in the north. *Ulaken* was a universal and indispensable staple. Tribes of several nations gathered every spring for the *ulaken* run in the neighborhood of the present Fishery Bay. During several weeks, exchanges of all kinds, barter, social contacts and quarrels were normal. Cultural features of the Nass as a result were observed by the strangers and imitated, wood carving in particular. The Nass River carvers are known to this day to have been about the best in that whole country. And their totem poles were the finest and the tallest seen anywhere. The twenty that stood there until recently were on the whole the tallest, and the best on the sea coast. They were also the oldest.



FIGS. 1–6.—For explanation see opposite page.

PALEONTOLOGY.—*New data on upper Martinsburg fauna.*[1] MARK H. SECRIST, Department of Geology, The Johns Hopkins University. (Communicated by EDWARD W. BERRY.)

This paper presents a preliminary account of an exposure of upper Martinsburg shale at its contact with the overlying Oswego sandstone. The section, revealed by recent highway construction, is at the Water Gap in Blue (First) Mountain, along the west bank of the Susquehanna River, on Pennsylvania Highway Route 14, about seven miles north of Harrisburg.[2]

The section has been visited from time to time during the fall and winter of 1937–1938. Since the fauna listed in this paper seems to be unusually varied, the author wishes to call attention to the locality. Systematic study will be carried on during the field season of 1938.

The upper Ordovician section (generalized) follows:

Silurian: Tuscarora Formation

Massive, grayish-white sandstone. Makes the crest of Blue Mt. N75E75S at the contact with the Juniata sandstone.

Ordovician: Juniata Formation

Predominantly red sandstone, cross-bedded, with conglomerate lenses in the lower portion. A few conglomerate lenses and thin shale beds are scattered through the formation. The contact with the overlying Tuscarora formation is taken where there is a decided change in color, from red to grayish-white. The contact with the Oswego is fairly sharp. N8[illegible]E66S at the contact with the Oswego sandstone.... 100 ft.

Oswego Formation

Mostly massive gray to reddish-brown conglomerate with scattered shaly beds. The contact with the underlying Martinsburg shale is sharp, showing a slight angular unconformity of about 3°. N85E80S at contact with the Martinsburg shale..... 79 ft.

[1] Received June 18, 1938.

[2] WILLARD, B. and CLEAVES, A. B. *A Paleozoic section in south-central Pennsylvania.* Pa. Top. & Geol. Sur. Bull. G8: 5–8. 1938.

FIG. 1.—*Lingula riciniformis* (Hall). Mold of ventral valve, ×4. FIG. 2.—*Cryptolithus bellulus* (Ulrich). Top view of well-preserved cranidium, ×5, showing the relative breadth of the species as well as the straightness of the anterior and posterior margins. FIG. 3.—*Cryptolithus tesselatus* (Green). Dorsal view of a nearly complete specimen, ×5. A portion of the inverted anterior brim of a second specimen is looped around the pygidium. FIG. 4.—*Cryptolithus tesselatus* (Green). Dorsal view of the mold of a nearly complete specimen almost encircled by the inverted buckler of a second specimen of equal size, showing the length of the genal spines, ×5. FIG. 5.—*Odontopleura* sp. Dorsal view of an entire individual, ×7, showing details of cephalon lobation and marginal ornamentation. FIG. 6.—The mold of the same specimen as FIG. 5, showing additional details of surface ornamentation and sculpture.

Martinsburg Formation

Dark blue-gray to brown, thin bedded, hackly shale which weathers rusty. N80E77S at the contact with the Oswego ss. Owing to its soft, unresistant nature, the shale is crumbling rapidly into soil. Observed in place..... 25 ft.

All the formations are overturned to the south.

The exposed Martinsburg shale is fairly fossiliferous up to the Oswego contact.

The following fossils were collected from the Martinsburg:

Crinoidea, columnals; *Cornulites* sp.; *Bryozoa* sp.; *Lingula riciniformis; L. curta; L.* sp. ind.; *Pholidops* cf. *cincinnatiensis; Plectorthis plicatella; Dalmanella testudinaria; Parastrophia hemiplicata; Sowerbyella rugosus; Rafinesquina alternata* var.; *R. squamula; Leptaena* sp.; *Cuneamya elliptica; C. aff. neglecta; C.* sp.; *Ctenodonta* sp.; *Clidophorus* cf. *scitulus; Colpomya faba-pusilla; C. faba* mut. *intermedia; Psiloconcha subovalis; Sinuites cancellatus; S. granistriatus; S.* sp.; *Plethospira quadricarinata; Eccyliomphalus* (?) sp.; *Holopea* sp.; *Hyolithes* sp.; *Geisonoceras amplicameratum; G. tenuitextum; Cryptolithus bellulus; C. tesselatus; Triarthus eatoni; Odontopleura* sp.; *Lepidocoleus jamesi.*

The above faunal assemblage, including 36 species distributed among 26 genera, corresponds very closely to the Lorraine fauna[3] of New York and also to the Eden fauna of the Ohio basin.

A few forms apparently have a range which is more extensive than either the Eden or the Lorraine. It is hoped that additional work may clarify their significance.

PALEOBOTANY.—*The age of the Carboniferous strata of the Paracas Peninsula, Peru.*[1] CHARLES B. READ, U. S. Geological Survey. (Communicated by JOHN B. REESIDE, Jr.)

The succession of Paleozoic floras in the Southern Hemisphere has for many years been of interest to geologists. The distribution of these floras both in time and in space and their contrasts with the northern floras of apparently similar ages lead into problems of paleogeography and of geographic distribution of organisms which are still largely unsolved. The general nature of the succession of strata and the contained floras is too well known to require review here. However, a fact perhaps not so well known is the building up in recent years of evidence suggesting an intermingling of boreal and austral floral ele-

[3] Ruedemann, R. *The Utica and Lorraine formations of New York*, Pt. I, *Stratigraphy*, N. Y. State Mus. Bull. **258**: 1925. Pt. II, *Systematic Paleontology*, N. Y. State Mus. Bull. **262**: 1925 and **272**: 1926.

[1] Published by permission of the Director, Geological Survey, U. S. Department of the Interior. Received June 9, 1938.

ments at a few localities. Likewise, a few "outpost" or "relict" floras, depending on the interpretation, have been described. The evidence in most cases seems adequate. The Permian Kousnetzk floras in Siberia are cases of this sort in the Northern Hemisphere. An intermingling of a rather different sort has been indicated in the Wankie coal field in Rhodesia, where a so-called *Glossopteris* flora contains a few northern fernlike types (16). In South America in Brazil, and to a certain extent in Argentina (9, 10, 18), there are known floras which appear to be similar to those of the Wankie region.

From the Paracas Peninsula on the coast of Peru (lat. 13°55′ S., long. 76°33′ W.) one of the most interesting of these northern relict or outpost floras has been described (1, 2, 8, 13). There, according to Berry's published accounts, a fault block of continental Carboniferous strata carries a flora which is Westphalian in age. This is of particular interest inasmuch as it is one of the very few if not the only known occurrence of such strata on the west coast of South America. Likewise, Berry's list, published in 1922, of the species present in the largest collection described from Paracas indicates that the flora is completely boreal in type.

More recently it has been suggested by both Gothan (8) and Seward (13) that the flora is lower Carboniferous. Even before Berry's paper there was some difference of opinion. Fuchs (7) in 1900 referred the flora to the upper Carboniferous. A little later Steinmann (14) indicated the age should more properly be regarded as lower Carboniferous. Identifications by Zeiller (19) in 1917 suggest Westphalian age.

Schuchert (12) in 1932 stated that "the occurrence at Paracas, Peru, is lower Carboniferous in age or at most oldest Pennsylvanian." Du Toit (6) in his recent book seems to be somewhat uncertain. And in his volume on "*Plant life through the ages*," Seward also seems hesitant to pronounce final judgment. Thus there has been in the past some difference of opinion regarding the age and interpretation of the flora. If it is upper Carboniferous (Westphalian) it is exceedingly interesting as an outpost of the northern flora far in the Southern Hemisphere. On the other hand, if it is lower Carboniferous it is typical of the floras of that age already known from several localities in the Southern Hemisphere and in consequence raises no particularly important phytogeographic problems.

Accordingly, it was with a great deal of interest that the writer recently began the examination of a collection made from the Paracas Peninsula in 1922 by Harvey Bassler. This study was in connection

with a review of South American Paleozoic floras preliminary to a detailed report on collections of fossils from Brazil.

Bassler's statement regarding the occurrence of the fossils is as follows: "My small collection was made as a pleasant incident of a very busy day, from the rock debris which had been hauled up during the excavation of a shallow shaft in the sag at the neck of the peninsula. This debris had already been rather thoroughly broken up and doubtless furnished some of the plant material of which mention has been made in the several papers concerning this locality."[2]

Although the collection was made very hurriedly and from debris picked over on several previous occasions by other collectors, Bassler was particularly fortunate in that he obtained several species belonging to genera which definitely determine the age of the deposit and also relate it to other occurrences in South America as well as elsewhere in the Southern Hemisphere. The determinable forms are as follows:

Sphenopteris parasica Gothan; *Adiantites whitei* (Berry), n. comb.; *Adiantites peruianus* (Berry), n. comb.; *Adiantites bassleri*, n. sp.; *Rhacopteris ovata* (McCoy) Walkom; *Rhacopteris* sp. cf. *R. cuneata* Walkom; *Aphlebia australis*, n. sp.; *Lepidodendron peruvianum* Gothan; *Lepidophyllum* sp. Gothan; *Calamites peruvianus* Gothan.

This flora is clearly lower Carboniferous and cannot be regarded as Westphalian. It is, in fact, late Dinantian, or at the latest, early Namurian in age. This is shown by the presence in abundance of *Rhacopteris ovata* and by the several species of *Adiantites*, a genus common in the lower Carboniferous. The first mentioned species, *R. ovata*, is perhaps the most common species present in the so-called *Rhacopteris* flora characteristic of the lower Carboniferous of the Gondwana province.

It is probable that this flora is of about the same age as that known in western Argentina in the general region of Barreal and San Juan, where occur *Rhacopteris ovata* (McCoy) Walkom (=*R. inaequalatera* Goeppert), *Adiantites antiquus* Ettingshausen, *Cardiopteris polymorpha* Goeppert, *Archaeopteris argentinae* Kurtz, and *Lepidodendron veltheimianum* Sternberg among other forms (10). These plants are from stage 1 of the Paganzo "system" of Bodenbender (3), which is regarded as ranging in age from late lower to upper Carboniferous.

Similarly the flora is correlative with that of the Kuttung series of

[2] Bassler, Harvey, personal communication, February 16, 1938.

New South Wales. That series, according to the Australian geologists, is late lower and early upper Carboniferous (4, 15).

It is difficult to place precisely the Paracas flora in the North American Carboniferous. In a general way, however, the flora corresponds to certain floras known, but undescribed, from the lower portion of the Mauch Chunk and from the upper part of the Pocono.

The appended remarks on the species present in the Bassler collection are brief diagnoses and discussions of the important elements in the flora necessary to support the remarks made concerning the age of the strata in question.

Adiantites bassleri, n. sp. Fig. 7

Frond unknown but presumably compound. Ultimata pinna slightly sinuose angularly, rather narrow, striate longitudinally, bearing widely spaced pinnules which are deeply divided into 3, 4, or 5 narrow, elongate cuneate lobes. Pinnules alternate, attached at the base by a very short footstalk. Nervation unknown.

This species is known from only a few fragments, the most complete being seen in the figure. It suggests *Adiantites antiquus* Stur, from which it is clearly distinct, differing in the larger size of the pinnules and their more elongate outlines.

As is indicated above, the venation is unknown in the specimen which is preserved in a dark sandy matrix. A sketch of the plant has been prepared from the photograph originally made, and this drawing is reproduced in figure 7. The relatively large size of the pinnules and their rather elongate shape are features of distinction, although the form does approach an undescribed species from the Mississippian of the Appalachian trough.

Sphenopteris parasica Gothan Fig. 2

Palmatopteris furcata (Brongniart) Potonié. Berry, Johns Hopkins Univ. Studies in Geology **4**: 15–17, pl. 1, figs. 1–3. 1922.

Sphenopteris parasica Gothan, Neues Jahrb. **59** (B): 293, pl. 13, fig. 1. 1928.

Fronds of unknown size, pinnae open, inclined to be irregularly flexuose, the ultimate pinnae rather distant. Ultimate pinnae set at open angles on the pinnae of the next lowest order, similar in flexuose nature, the pinnules rather distant. Pinnules cuneate or triangular in gross outline, deeply incised into cuneate segments, each of which bears from two to four veins originating from a single basal vein supplying all segments of the pinnule.

To some extent this species suggests *Rhodea tenuis* Gothan and *R. smithi* Kidston, both of which are lower Carboniferous forms. In fact, on the basis of the highly divided nature of the pinnules, this plant should perhaps be placed in *Rhodea* rather than *Sphenopteris*. From *R. smithi* the plant here described differs in its somewhat larger size as well as in the somewhat broader laminae, which are rounded apically rather than acutely round pointed. *R. tenuis* is a somewhat smaller, more compact type.

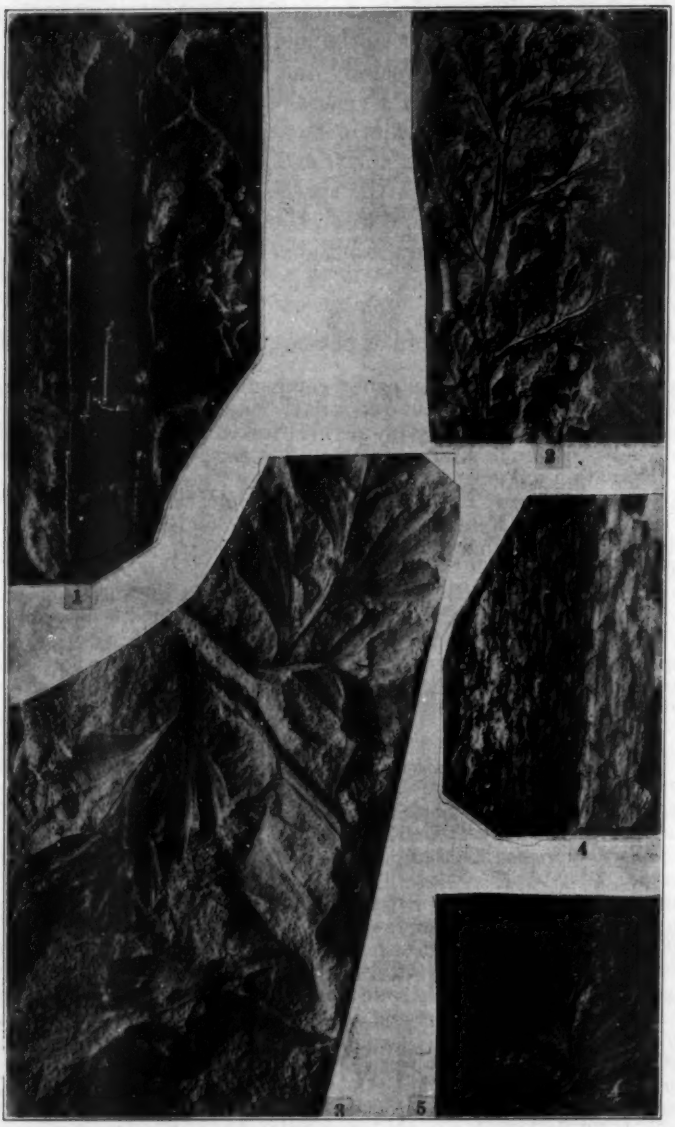


FIG. 1.—*Rhacopteris ovata* (McCoy) Walkom. FIG. 2.—*Sphenopteris parasica* Gothan. FIG. 3.—*Adiantites peruianus* (Berry), n. comb. FIG. 4.—*Lepidodendron peruvianum* Gothan. FIG. 5.—*Rhacopteris* sp. cf. *R. cuneata* Walkom.

Adiantites whitei (Berry), n. comb.

Eremopteris whitei Berry, Johns Hopkins Univ. Studies in Geology **4**: 20–21, pl. 4. 1922.

This species has already been described in considerable detail, and the present writer has nothing to add to the description. However, the species appears to be more properly referable to the genus *Adiantites* than to *Eremopteris*.

Very little of this material is present in the Bassler collection and that poor. In consequence these remarks are based in part on Berry's illustration and description. The pinnules are, when lobed, apparently arranged fasciculately. The pinnule outlines appear rather typically *Adiantites*-like but are smaller than *A. peruvianus* and do not show the erose apices characteristic of that species.

Adiantites peruianus (Berry), n. comb. Fig. 3

Eremopteris peruianus Berry, Johns Hopkins Univ. Studies in Geology **4**: 19–20, pls. 2–3. 1922.

This species appears to be referable to *Adiantites* rather than to *Eremopteris*.

In the grouping of the pinnules into fasciculate bundles and in the general form of the divisions this species is rather typical of *Adiantites*. However, in the rather erose and sometimes denticulate pinnule apices there are features which are not commonly seen in the genus. It is, in fact, very distinct and should not be confused with any other known species.

Rhacopteris ovata (McCoy) Walkom Fig. 1

Otopteris ovata McCoy, Annals and Mag. Nat. History **20**: 148, pl. 9, fig. 2. 1847.

Rhacopteris inaequalatera Feistmantel, New South Wales Geol. Survey, Mem., Paleontology **3**: 97. 1890.

Rhacopteris ovata (McCoy) Walkom, Linnean Soc. New South Wales, Proc. **59** (5–6): 431–432. 1934

The Paracas collection made by Bassler includes a number of specimens of this important species. It must be borne in mind that this form is one of the index fossils to the lower Carboniferous strata of the Southern Hemisphere. Hence its presence in the Paracas flora points conclusively to the early Carboniferous age of the strata exposed at that locality.

The specimen figured is rather typical of the species and is the best preserved fragment in the collection. However, the species is abundantly represented, being perhaps the most common form present.

Rhacopteris sp. cf. **R. cuneata** Walkom Fig. 5

The single fragment which is referred with considerable hesitation to Walkom's species (16) appears to also resemble the specimen of *Rhacopteris circularis* Walton figured by Gothan (8) from Vichaicoto, south Huanuco. The material at hand is insufficient to determine clearly the specific position of the form. However, it almost certainly belongs to *Rhacopteris*.

Walkom's species, it will be recalled, was described as *?Sphenopteridium cuneatum*. In his discussion Walkom pointed out that there were resemblances to *Rhacopteris* and indicated that the plant might be included in that genus. To the present writer the assignment to *Rhacopteris* is preferable.

Walkom's plant seems to be characterized by a slightly more compactly lobed pinnule than the Paracas fragment. The features of both are rather vague, however, and do not permit more than a very superficial comparison which does suggest close similarity, if not identity.

Aphlebia australis, n. sp. Fig. 6

Lamina apparently membranaceous, lax, flabellate, showing abundant dichotomies to form a highly divided leafy organ, base unknown. Venation not very distinct, apparently consisting of a single broad vein which forks

FIG. 6.—Sketch of *Aphlebia australis*, n. sp., showing the highly dichotomous and lax structure of the organ. Traced from photograph. FIG. 7.—Sketch of *Adiantites bassleri*, n. sp., slightly restored.

following the division of the lamina, each lobe carrying but a single vascular strand. Apices of the lobes apparently pointed, very acute.

The single specimen known of this form is a fragment revealing only the highly dichotomous lamina and shows little of either the base or of the ultimate divisions. As has been indicated above, the organ is a highly dichotomous one, very lax in its aspect, and traversed by a very simple system of a single vascular strand. Its relationship to the fern and fernlike elements of the Paracas floras is, at best, quite speculative.

Lepidodendron peruvianum Gothan Fig. 4

Lepidodendron rimosum Sternberg. Berry, Johns Hopkins Univ. Studies in Geology 4: 24–26, pl. 8. 1922.

Lepidodendron obovatum Brongniart. Berry, Johns Hopkins Univ. Studies in Geology 4: 26–27, pl. 1, fig. 5. 1922.

Lepidodendron peruvianus Gothan, Neues Jahrb. **59** (B): 294–295, pl. 13, fig. 2. 1928.

The material referred by Berry to *Lepidodendron rimosum* Sternberg and *L. obovatum* Sternberg appears to be more properly referable to Gothan's *L. peruvianum*. Both the specimens figured by Berry as *L. obovatum* and *L. rimosum* do not seem very close to those species as the writer understands them. The specimen in figure 2, plate 8, of Berry's paper is simply partly decorticated and is almost certainly referable to the same species as that in plate 1, figure 5. The proportions of the bolsters in all these Paracas specimens differ markedly from those of *L. obovatum*. The latter has a very symmetrical rhomb-shaped bolster, while the South American specimens show the widest point plainly above the middle. Likewise the leaf scars are higher in the latter than in the former.

The resemblances to *Lepidodendron rimosum*, with its elongate, slightly sinuous bolsters, are slight. None of the Paracas specimens examined by the writer seems close.

Calamites peruvianus Gothan

Calamites suckowi Brongniart. Berry, Johns Hopkins Univ. Studies in Geology **4**: 21–23, pls. 5–7. 1922.

Calamites peruvianus Gothan, Neues Jahrb. **59** (B): 294, pl. 14, fig. 1. 1928.

Material referable to *Calamites* is quite rare in the collection made by Bassler. However, the few specimens seen appear to be nearer to Gothan's *C. peruvianus* than to *C. suckowi* Brongniart.

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ZOOLOGY.—*A new* Liolaemus *and two new* Syrrhopus *from Peru.*[1]

BENJAMIN SHREVE, Harvard University. (Communicated by THOMAS BARBOUR.)

This paper deals with some novelties found in a collection of Peruvian reptiles and amphibians made by Warren F. Walker, Jr. Mr. Walker intended to work out this collection himself but due to the pressure of college studies he was unable to complete the task. Hence it became my lot to finish identifying the collection and to publish the descriptions of the new forms found therein.

Liolaemus walkeri sp. nov.

Type:—Museum of Comparative Zoology no. 43770, a male, from Llocllapampa, circa 10,000 feet altitude, Department of Junin, Peru, collected by Warren F. Walker, Jr., June 26 to July 3, 1936.

Paratypes:—Museum of Comparative Zoology nos. 43771–9 and ten uncatalogued specimens with the same data as the type. Many paratypes are gravid females.

Diagnosis:—Allied to *Liolaemus gracilis* and *bibronii;* from the former it differs in possessing a larger scale count around the middle of the body, an antehumeral fold, hind limbs averaging shorter, and in coloration; from the latter it differs in not having mucronate dorsal scales, a larger average number of anal pores, and in coloration. This new form is also allied to *Liolaemus alticolor* from which it differs in having smooth temporal scales, and in not having mucronate dorsal scales, and in coloration.

Description:—Nostril lateral; upper head scales rather large, smooth; an azygos frontal separated from the interparietal by a pair of frontoparietals, the right frontoparietal being divided more or less longitudinally (in the paratypes, frontoparietals variously fused or split); interparietal as large as, or larger than, parietals (also, smaller than parietals in many paratypes); a series of about three enlarged supraoculars (about three or four in paratypes); a single series of scales between the labials and infraorbital (in some paratypes, part of one labial is actually in contact with infraorbital); temporal scales smooth; ear opening with indistinct denticulation in front (fairly distinct in some paratypes); sides of neck covered with very small scales, with an irregular, longitudinal fold; a short, curved antehumeral fold; dorsal scales moderate, more or less rhomboidal, strongly keeled, pointed, although not mucronate; ventral scales slightly larger or about the same size, rounded, hexagonal, or rhomboidal, smooth; about 58 scales around the middle of the body (about 50–62 in paratypes); about 63 scales from occiput to rear of hind limb (about 55–68 in paratypes); the adpressed hind limb reaches the axilla (from the axilla, or a little further, to well behind the

[1] Received July 2, 1938.

axilla in paratypes); hinder side of thighs uniformly granular; 4 anal pores (4–6 pores in five paratypes, the rest with none; apparently present in males only, as in other members of the genus); caudals as large as, or larger than, dorsals.

Coloration in alcohol:—Above, brown (gray where outer epidermis has peeled off), a narrow, dark brown or black vertebral stripe extending from the neck almost to the end of the tail, rather broken on the tail; a light grayish stripe about two scale rows wide beginning at the upper posterior border of the eye extending on to the tail where it becomes obsolete; below this stripe, on the side, another narrower and more obscure beginning at the lower posterior border of the eye and extending to the hind limb, almost obsolete in front of the ear; dark brown or black spots on the dorsum and head, on the dorsum extending as far as the lowest stripe; also, below the upper grayish stripe, sides speckled with whitish; below, gray, rear of hind limbs, belly, and chest overlaid with black; throat and underside of head marked with black; chin blackish gray; therefore, it is seen that the ground color is largely obscured; underside of tail grayish, spotted with blackish.

The five paratypes with anal pores, which are all males, differ somewhat from the type in coloration. In no. 43772, the largest of these, the dark vertebral stripe and the lower light stripe are absent, the stripe that is present being ill defined, and there are no dorsal spots on this individual; in the smaller examples, the dorsal and lateral stripes are much more distinct even than in the type, the beginnings at the eye being plainly visible; below, in the smaller individuals, the black of the belly extends not at all or but little onto chest; in no. 43775, the smallest of these five, the body is uniform blackish gray below, without black markings. Males of this species, as they become older, become more indistinctly striped above and more extensively black below.

The female coloration is like that of what are apparently juvenile males, with the stripes perfectly distinct and the underside of the body light gray to blackish gray, darker on chin, with the black being absent.

Underside of tail in all paratypes is grayish or whitish brown, marked, or unmarked with dark brown; also the vertebral stripe may be margined with grayish and may be unbroken on tail; light stripes may be whitish brown as well as grayish; dorsal spots are sometimes lacking as also spots on the head.

Measurements:—

	Length head and body	Tail[1]	Total length	Hind limb	Hind foot
Type no. 43770	54 mm	69 mm	123 mm	27 mm	14 mm
Paratypes nos. 43771–9 and ten uncatalogued specimens	60–30 mm	67–42 mm	127–72 mm	28–16 mm	15–8 mm

[1] The tail of type and largest paratype regenerated.

This species is named for Warren F. Walker, Jr., the collector of a valuable Peruvian herpetological collection which he has kindly presented to the Museum of Comparative Zoology.

Remarks:—Specimens of this species in the Museum of Comparative Zoology from Ticlio, circa 15,600 feet altitude, Department of Lima, and Janchiscochas Mine, 40 kilometers north of Jauja, Department of Junin, present certain small differences from the type series which may or may not entitle them to separate recognition. For example, one of the Ticlio

series, the only one with any pores, has but three. Therefore, these specimens were not included as paratypes.

Syrrhopus montium sp. nov.

Type:—Museum of Comparative Zoology no. 22858 from Cascas, near Huasahuasi, Department of Junin, Peru, collected by Warren F. Walker, Jr., August 31, 1936.

Paratypes:—Museum of Comparative Zoology nos. 22859–61 with the same data as the type.

Diagnosis:—Allied to *Syrrhopus simonsii* from which it differs in having shorter hind limbs, no dorsal warts forming longitudinal folds, and in coloration.

Description:—Tongue suboval, entire; vomerine teeth none; snout rounded, longer than the diameter of the eye; loreal region concave and oblique; canthus rostralis distinct, curved; nostril a little nearer the tip of the snout than the eye; interorbital space slightly broader than upper eyelid; no tympanum, tips of digits not or but extremely feebly swollen; digits short; first finger slightly shorter than second; first toe shorter than second; inner metatarsal tubercle rather large but ill defined, outer virtually indistinguishable from many surrounding poorly defined tubercles; the tibiotarsal articulation of the adpressed hind-limb does not reach the axilla (it does in two paratypes); granulate above, especially posteriorly; sides very coarsely granulate; belly, chest, throat, and lower surface of thighs also very coarsely granulate.

Coloration in alcohol:—Above, dark purplish brown, limbs obscurely crossbanded with darker; the inner side of hand and the two inner fingers, inner side of foot and the three inner toes white, both above and below, this white also marked in places with dark purplish brown; below whitish, belly slightly suffused and marked with purplish brown, underside of limbs, except outer part of lower side of thighs, and on the hands and feet as previously noted, colored like dorsum.

The coloration of the paratypes is essentially similar to that of the type except the crossbands on limbs may be absent; below, there may be extensive white areas on limbs, and below the dark suffusion may be a bit more pronounced than in type.

Measurements:—

	Length of head and body	Head	Hind limb	Fourth toe
Type no. 22858	29 mm	10 mm	30 mm	6 mm
Paratypes nos. 22859–61	26–21 mm	10–7 mm	30–27 mm	7–6 mm

Syrrhopus juninensis sp. nov.

Type:—Museum of Comparative Zoology, no. 22851, a male from Cascas near Huasahuasi, Department of Junin, Peru, collected by Warren F. Walker, Jr. August 31, 1936.

Paratypes:—Museum of Comparative Zoology nos. 22852–7 with the same data as the type.

Diagnosis:—Allied to the preceding species from which it differs in being smooth below, in having a more distinct outer metatarsal tubercle, a distinct fold above the spot where the tympanum should be, and in coloration.

Description:—Tongue suboval, entire (very slightly nicked in some paratypes); vomerine teeth none; snout rounded, longer than the diameter of the eye (about the same length in some paratypes); loreal region concave

and oblique, canthus rostralis distinct, curved, nostril slightly nearer the tip of the snout than the eye; interorbital space about as broad as upper eyelid or a bit narrower; no tympanum, a distinct fold over the tympanic area; tips of digits very feebly swollen or not swollen at all; digits fairly short; first finger slightly shorter than second; first toe shorter than second; toes unwebbed at base; inner metatarsal tubercle rather large, outer decidedly smaller; the tibio-tarsal articulation of the adpressed hind limb reaches the axilla (a bit beyond the axilla in two paratypes); above with low, rather indistinct warts, especially posteriorly (warts more distinct in some paratypes, in others almost obsolete); smooth below.

Coloration in alcohol:—Above, dark gray, decidedly lighter on sides and on limbs, an obscure blackish crossband between the eyes, a similar band from the nostril to the eye and from the posterior corner of the eye along the "supratympanic" fold; dorsum obscurely marked with blackish; below, brownish white, suffused with light gray.

In some paratypes the obscure band anterior to the eye starts at the tip of the snout; also the "supratympanic" blackish marking may be absent. In addition, the limbs above may be obscurely crossbanded; while in some the middle of the back is not darker than the sides; markings above quite distinct in one paratype.

Measurements:—

	Length head and body	Head	Hind limb	Fourth toe
Type no. 22851	31 mm	10 mm	44 mm	9 mm
Paratypes nos. 22852–7	30–23 mm	10–8 mm	39–29 mm	8–6 mm

Remarks:—Both of these frogs have been found on dissection to have a broad cartilaginous sternum and more or less T-shaped terminal phalanges. These characters, in addition to the absence of vomerine teeth, would indicate membership in the genus *Syrrhopus*.

The terminal phalanges appear to be more T-shaped than in *Eusophus* hence these are not considered members of that genus without vomerine teeth. It appears likely that *Syrrhopus*, *Eleutherodactylus* and *Eusophus* may eventually be merged. See H. W. Parker, Ann. Mag. Nat. Hist. 10 (10): 344. 1932.

ICHTHYOLOGY.—*Status of the Asiatic fish genus* Culter.[1] HUGH M. SMITH, United States National Museum.

In 1855 Stephan Basilewsky published a paper in which were described various new genera and new species of Chinese fishes. None of the generic names except *Culter* has survived to the present time, all the others having long ago been discarded as synonyms.

The characters given in the definition of the genus were mostly applicable to several other cyprinoid genera, and scarcely a single distinctive feature was noted. One outstanding character was a dorsal fin situated over the space between the ventral and anal fins, with its second simple ray very robust and osseous. Included under the

[1] Received July 6, 1938.

genus was the well-known European fish *Cyprinus cultratus* Linnaeus, and six new species were described, of which the first three (*alburnus*, *erythropterus*, and *mongolicus*) had the abdomen compressed and carinate and the second three had the abdomen noncompressed. In two of the first three the natatory vesicle was noted as trilobed; in all of the last three it was given as bilobed.

The genus, obviously composite, has now been split up into at least four genera, *Hemiculter* (Bleeker, 1859), *Pseudoculter* (Bleeker, 1859), *Erythroculter* (Berg, 1909), and *Pseudohemiculter* (Nichols and Pope, 1927), while *Culter* proper has been retained for a few species of China, Formosa, and Siam in which the entire abdominal edge is trenchant (Berg; Nichols, 1928), or in which the abdominal edge is either trenchant throughout or trenchant only posterior to the ventral fins (Günther, 1868; Oshima, 1917).

If there were no other points involved, the status of *Culter* could be left here, but the case is not so simple.

In 1863 Bleeker designated *alburnus* as the type species of the genus *Culter*, putting it in a section of his general synopsis and key to cyprinoid fishes characterized by having the abdomen cultrate anterior to the ventral fins. In this course he was followed by Günther (1868) who, however, placed *alburnus* in the synonymy of *recurviceps* (Richardson, 1846), and in his description of the species said: "Abdominal edge trenchant from behind the ventrals, flattened between the ventrals and pectorals." Berg (1909) on the other hand recognized *alburnus* as a species in which the abdominal keel exists anterior to the ventrals and established his *Erythroculter* to accommodate Basilewsky's *erythropterus* with a trenchant abdominal edge only posterior to the ventrals. The position taken by Nichols and Pope (1927) was that "Whereas we suspect that Basilewsky's *alburnus* was actually a species with posterior keel only, quite likely identical with his *erythropterus*, one opinion is as good as another as to this and we follow Berg's ruling."

As a contribution to this phase of the present discussion, it is possible to quote from a letter dated April 29, 1937, from Mr. J. R. Norman, Assistant Keeper, Department of Zoology (Fishes), in the British Museum who had been requested to indicate just what undoubted specimens of *alburnus* and *erythropterus* in that institution actually showed as regards the abdominal edge. Mr. Norman courteously wrote:

> We have several specimens identified by Günther as *Culter recurviceps* (=*alburnus*) and *C. erythropterus* respectively and I have no reason to doubt

the correctness of these identifications. Both have the abdominal edge trenchant only posterior to the ventral fins.

In setting up *Culter alburnus* as the type of *Culter*, Bleeker and various writers who agreed with him in this course entirely ignored the fact that Basilewsky himself adopted or considered *Cyprinus cultratus* Linnaeus as the type of *Culter*. No other interpretation can be placed on the circumstance that, immediately after the first use of the name *Culter*, Basilewsky devoted an entire line to the words "Cypr. cultratus Linn." The case is clearly covered by the International Rules of Zoological Nomenclature, reference being made particularly to article 30, paragraph *g*, reading:

> If an author, in publishing a genus with more than one valid species, fails to designate or to indicate its type, any subsequent author may select the type.

That Basilewsky did select a type species by "indication" seems to be fully established by the international rules and the opinions thereunder, and Bleeker's action was void.

Although the point is not of vital importance, it may be noted that the original definition of the genus *Culter* fitted fairly well the species *cultratus* and that in the few particulars in which it did not apply it would have been subject to future emendation, correction, or amplification, as was done by Günther (1868) to make it fit the species he assigned to it.

In passing on the name *Culter* and its genotype, Jordan (1919) expressed the following opinion:

> *Culter* Basilewsky; logotype *C. alburnus* Basilewsky, as restricted by Bleeker and Günther. Under the head of *Culter* Basilewsky mentions especially *Cyprinus cultratus* L. . . . although he does not exactly specify this as type. He then proceeds to describe certain Chinese species. For some of these the name *Culter* has been kept, although Basilewsky plainly intended to make his type *Cyprinus cultratus*. At present we follow the authority of Bleeker and Günther.

If it were established that *Cyprinus cultratus* was not designated or indicated by Basilewsky as the type of *Culter*, that species would automatically have become the type under another provision of the International Rules of Zoological Nomenclature. Thus, paragraph *i* of article 30, which appears as a recommendation of the International Commission on Zoological Nomenclature, reads:

> If a genus, without designated type, contains among its original species one possessing as a specific or subspecific name, either as valid name or synonym, a name which is virtually the same as the generic name, or of the same origin or same meaning, preference should be shown to that species

in designating the type, unless such preference is strongly contraindicated by other factors. (Type by virtual tautonymy.)

The foregoing review has been intended to prepare the way for another aspect of this case.

The genus *Pelecus* was established by Louis Agassiz (1835) for the accommodation of *Cyprinus cultratus* Linnaeus, and the fish has ever since borne the name of *Pelecus cultratus*.

It therefore follows that Basilewsky's *Culter*, proposed twenty years later, was a synonym and that this name is not available for any of the various species which have from time to time been so designated, many of which, however, have already been placed in newly-established genera.

It now remains to provide for forms that are still carried under the name of *Culter*. These fall into two closely related genera which are named and diagnosed as follows:

Cultrops n. g. (Cyprinidae)

Body and head strongly compressed, with abdominal edge trenchant throughout; dorsal profile nearly straight and horizontal, ventral profile strongly and evenly decurved; eye in anterior half of head, postorbital region long; mouth subvertical; lower jaw with a strongly developed symphysial hook which fits into a corresponding depression in the upper jaw; no barbels; pharyngeal teeth triserial, with 4 uncinate teeth in each of the two outer rows and 2 shorter blunt teeth in the innermost row; gill openings wide; gill membranes narrowly united to isthmus; gill rakers numerous, long, setiform; natatory vesicle tripartite; scales small; lateral line slightly decurved, often consisting of 2 or 3 disconnected overlapping sections, and running in lower half of caudal peduncle; dorsal fin placed over the space between ventral and anal fins, with 7 branched rays and with last simple ray slender, weak, and non-osseous; caudal fin forked; anal fin with 23 to 25 branched rays; pectoral fins long.

Genotype.—Culter siamensis Hora, inhabiting Siam.

The genus *Paralaubuca* established by Bleeker in 1863 (Atlas Ichthyologique, III) for a common Siamese species (*typus*) is close to *Cultrops* (rather than to *Laubuca* with which Bleeker compared it) but seems to be sufficiently differentiated.

Cultrichthys n. g. (Cyprinidae)

Body and head strongly compressed, with abdominal edge trenchant from pectoral base to vent; dorsal and ventral outlines similar; eye in anterior half of head, postorbital region long; mouth subvertical; no postsymphysial knob or hook on lower jaw; no barbels; pharyngeal teeth slender, triserial, 5,4,2—2,3(or 4),4, or 4,3,1—1,3,4; gill openings wide; gill membranes narrowly united to isthmus; gill rakers numerous, long, setiform; natatory vesicle tripartite; scales small; lateral line with slight downward curvature; dorsal fin placed over the space between ventrals and anal or slightly over-

lapping origin of anal, with 7 branched rays and with the last simple ray smooth, stout, and osseous; caudal fin forked; anal fin with 28 to 30 branched rays; pectoral fins long.

Genotype.—*Cultur brevicauda* Günther, inhabiting Formosa and China.

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PHILOSOPHICAL SOCIETY

1135TH MEETING continued

J. W. MCBURNEY: *Freezing and thawing of brick.*—Freezing and thawing tests are rarely used as acceptance tests for building brick because of the length of time required to obtain results. The principal use of such tests in recent years has been in the evaluation of weathering classification of building brick. The classifications are based upon certain physical properties that can be readily measured in the laboratory. The most important of these properties is the C/B ratio which can be defined as the ratio of easily filled pore space to total fillable pore space. Twelve samples of 20 bricks each were selected from each of 5 large samples representing 5 different types of bricks so that the distribution of the physical properties of each small sample closely resembled each other small sample. These comparable small samples were frozen and thawed up to 75 cycles using 7 different techniques of freezing and thawing. Three types of exposure to weather were used on others of these small samples. The action of both laboratory freezing methods and natural exposures can be summed up by stating that the greater the degree of saturation at the time of freezing, the more effective was the method in producing disintegration. (*Author's Abstract.*)

The first paper was discussed by Messrs. KRACEK, HERSCHEL, MCNISH, and HECK; the second one by Messrs. TUCKERMAN, HECK, KRACEK, and STEVENSON.

An informal communication on the bisection of a horn angle was pre-

sented by A. S. HAWKESWORTH and discussed by Messrs. GOLDBERG and MCNISH.

1136TH MEETING

The 1136th meeting was held Saturday, May 7, 1938, in the Cosmos Club Auditorium, President HECK presiding.

Program: H. L. DRYDEN: *Liveliness of baseballs.*—At the request of Clark Griffith, President of the Washington Nationals, representing a committee of American League officials concerned with standardization of baseballs, and because of the considerable public interest in the matter, the National Bureau of Standards undertook to study methods of measuring the liveliness of baseballs and to determine whether the ball to be used by the American and International Leagues next season is livelier than that to be used by the National League.

The "liveliness" or in scientific language the resilience of a body is commonly determined by allowing it to fall and rebound from a suitable hard surface. A lively ball rebounds more than a dead ball. This method is, however, not at all satisfactory for baseballs. The principal reason is that the pitcher bounces the baseball off the bat in a home run hit with relative speeds far greater than can be obtained by dropping from any reasonable height. The impact of a ball dropped from the top of the Washington Monument or higher on to the pavement below is probably not as great as that of the bat hitting a fast ball. The falling ball is retarded by the resistance of the air and soon approaches a constant speed at which the air resistance equals the weight. This speed has not been accurately determined but is probably of the order of 120 feet per second. The relative speed at which the bat meets a fast ball is probably greater. In any case large corrections would have to be made for the effects of air resistance in the measurement of liveliness by dropping tests.

It is necessary to secure impacts comparable with those of a batted ball, since the liveliness decreases as the severity of the impact and the consequent deformation of the ball increases. The Bureau has constructed a machine which gives relative speeds of the right order of magnitude. The machine is an adaptation of apparatus developed by Professor H. A. Thomas of the Carnegie Institute of Technology for measuring the liveliness of golf balls. It consists of an air gun which shoots a one-pound hard-wood projectile representing the bat at speeds up to 200 ft/sec against the ball which is "teed" like a golf ball. After impact, the projectile and ball are caught in ballistic pendulums, by means of which their speeds can be determined. The resilience or "liveliness" is measured by the ratio of the relative speed after impact to the relative speed before impact.

Since balls of the same lot vary somewhat in weight, size, and physical properties, it was necessary to take a large number of measurements on a fair number of balls of any given type to obtain reliable average values. The measurements of the liveliness of the American and National League baseballs showed no difference of any practical significance. Some National League balls are more lively than some American League balls, and some are less lively. There are slight variations in liveliness of balls of either league, just as there are slight variations in weight within the official limits of 5 to 5¼ ounces and slight variations in circumference within the official limits of 9 to 9¼ inches. The differences between averages of three measurements on six balls of each type are small in comparison with variations in the individual measurements and would probably disappear if a very large number of balls were tested.

As a check on the laboratory measurements (and of greater interest to most people) the gun was taken to the ball park and used as a robot batter to drive out home runs. It was easily possible to knock the ball over the fence. Numerous measurements of distance were made under the same conditions in so far as possible. The average distance was the same for the American and National League balls within one foot, namely, 367 feet for the conditions used. Individual shots went from 320 to 410 feet, this scatter and lateral deflections up to 30 feet either way being largely due to the effect of the variable wind. (*Author's Abstract.*)

O. H. GISH and K. L. SHERMAN: *Electrical resistance of the atmosphere.*

The first paper was discussed by Messrs. ROLLER, TUCKERMAN, BUCKINGHAM, and HAWKESWORTH; the second one, which was presented by Mr. GISH, was discussed by Messrs. HAWKESWORTH and TUCKERMAN.

An informal communication on "Fibonacci Redivivus" or "The Fecund Rabbits" was presented by Mr. L. B. TUCKERMAN. This was discussed by Messrs. MCNISH, HUMPHREYS, and GOLDBERG.

1137TH MEETING

The 1137th meeting was held Saturday, May 21, 1938, in the Cosmos Club Auditorium, President HECK presiding.

Program: W. C. LOWDERMILK: *The recent floods in southern California.*—The flood of March 1938 in Southern California was the most disastrous since the historical record began in the founding of the San Gabriel Mission in 1771. Because of highly developed culture and density of population, flood waters were more destructive to the interests of human inhabitants than ever before. Eighty-three persons lost their lives and 116 were injured and nearly 5,000 families required assistance and rehabilitation. The losses in property destroyed and damaged approximated 83 millions of dollars. The flood affected principally the four drainage basins of the Los Angeles, San Gabriel, Santa Ana and Santa Clara Rivers. Highway and railway bridges were washed out. Highways and roads were cut through; stream channels were deepened and widened under cutting banks; densely populated communities were overwhelmed by overwash and extensive areas of agricultural lands were damaged or ruined by the overwash of sands, gravels and boulders and cultivated fields on sloping lands suffered serious erosion throughout the area. The total rainfall of two storms coming one close upon the other varied from 7 inches in the coastal plains to 30 inches above 7000 feet in the mountains. Melting of winter snows above the 6,000 feet level added to the flood runoff. Rain intensities equalled as much as 3 inches per hour per 15 minutes and there was as much as 11 inches of fall in 12 hours at the higher elevations. But greater rainfall has occurred in the past, such as in the winters of 1861–62, 1884–85 and in 1889. Such storms may be expected to occur from time to time in the future. Important lessons in the interests of flood control and water conservation may be learned from this flood.

The flood control dams were effective in reducing runoff peaks up to 50 percent and plans for construction of additional flood control reservoirs appear to be fully justified.

Debris in the flood currents presents the greatest problem in the control of flood waters for this area. The 16 debris basins constructed along the mountain front were effective in unloading heavily charged runoff and mud flows. Cleaning out of the debris basins represents a heavy cost of flood protection. The flood control reservoirs, moreover, were filled to surprising de-

gree by debris washed out of tributary mountain streams. The capacities of reservoirs were reduced from 5 to 77 per cent by this one storm.

The importance of maintaining the sloping lands of the agricultural areas in cover crop vegetation and of the mountain slopes with grass or chaparral forests was demonstrated in this storm. It is also apparent that such safeguards in runoff control must be supplemented by engineering structures to secure a reasonable control of flood runoff. (*Author's Abstract.*)

This address was discussed by Messrs. HECK, CURTIS, TUCKERMAN, GREGG, BERNARD, and WENNER.

Mr. P. R. HEYL presented an informal communication on "The Law of Anomalous Numbers." Mr. M. GOLDBERG presented an informal demonstration of "Polyhedral Chain Linkages." The latter was discussed by Mr. L. B. TUCKERMAN.

H. E. MCCOMB, *Recording Secretary*

GEOLOGICAL SOCIETY

554TH MEETING

The 554th meeting was held at the Cosmos Club October 27, 1937, President R. C. WELLS presiding.

Program: GORDON RITTENHOUSE: *Criteria used in recognizing modern fluvial sediments.*—Those fluvial deposits formed by accelerated sedimentation resulting from agricultural use of uplands are defined as Modern sediments. Methods used to recognize and determine the thickness and lateral extent of such deposits fall in two classes, (1) those which give reasonably accurate determination of the total amount of modern aggradation, and (2) those which indicate the minimum amount of aggradation or the amount of aggradation during a known period of time.

The first of these methods involves identification of the premodern soil by (a) darker color, (b) presence of ferruginous concretions, or (c) "bleached" colors. Texture probably cannot be used as a criterion to differentiate between modern and pre-modern sediments.

The minimum amount of aggradation or the amount of aggradation during a known period of time may be determined (a) by comparison of new and old instrumental surveys or (b) by the use of natural or artificial gages.

The use, as criteria, of geomorphic changes resulting from accelerated sedimentation is not discussed.

H. D. MISER and R. E. STEVENS: *Taeniolite, a rare lithium-magnesium mica from Magnet Cove, Arkansas.*

TAISIA STADNICHENKO: *Organic sediments as indices of regional metamorphism.*

555TH MEETING

The 555th meeting was held at the Cosmos Club November 10, 1937, President R. C. WELLS presiding.

Informal communication.—Charles Milton stated that a sample submitted by the Park Naturalist of the Yosemite National Park to the Geological Survey for determination turned out to be copiapite, a hydrous ferric sulphate, forming a crust on a weathered siliceous rock. A letter received subsequently from Mr. Matthes of the Survey states that the deer in the Yosemite seek it avidly, and consume it in place of salt which is extremely scarce in the region. On enquiring at the Biological Survey of the Department of Agriculture concerning this, it was learned that this was a very un-

usual thing, and the expert consulted said he had never heard of it before; he added, however, that deer sometimes show a craving for other things of bitter taste, such as the bark of willow trees.

Program: G. W. RITCHEY: *Lava flows on the moon.*

F. E. WRIGHT: *Progress in the study of surface features of the moon.*

P. B. KING: *Tectonics of the Guadalupe Mountain region.*

556TH MEETING

The 556th meeting was held at the Cosmos Club November 24, 1937, President R. C. WELLS presiding.

Program: J. C. MILLER: *The occurrence and commercial use of carbon dioxide.*

B. E. JONES: *Advantages of resistivity measurements in the examination of dam sites.*

C. P. ROSS: *Erosion in the Lost River Range, Idaho.*—The sharp contrast between the high, rugged Lost River Range with its moderate rainfall and the wide, alluvium-filled, semi-arid valleys on either side emphasizes some features of erosion. The mountains are being actively carved by streams, frost, and wind but the lowlands, partly because of exceptionally abundant alluvium, show comparatively few permanent stream channels. Even within the mountains, few of the larger valleys contain streams that flow at the surface during most of the year. Land sculpture and the transportation of waste are accomplished by sporadic floods that spread and shift rather than by the orderly extension of established drainage channels. Here, as elsewhere, streams tend to entrench themselves and to extend such trenches headward wherever possible. High in the mountains this is the most effective method of erosion but on the valley borders only the master streams are able to establish relatively permanent and continuous channels. In extreme instances mountain valleys end in funnel-like depressions in the alluvium at the valley border. The comparatively important role played by short, vigorous floods from upstream has resulted locally in the formation of conspicuous, embanked gullies and gulches in which walls are formed by the pushing aside of material loosed by the rushing water in excess of the amount it can carry downstream.

557TH MEETING

The 557th meeting was held at the Cosmos Club December 8, 1937, President R. C. WELLS presiding.

Program: Presidential Address by R. C. WELLS: *Present trends in geochemistry.*—Geochemistry is chemistry applied to geology, petrology and mineralogy. It considers where each chemical element is found and how much there is of it. Isotopes must also be considered. The major problem is to explain the origin of natural products. The sizes of the different atoms, as well as their arrangement, affect the physical properties of minerals. Rocks may be classified from their chemical analyses. Phase rule studies help to generalize knowledge concerning the formation and associations of minerals. Ores and the weathering products of rocks are continuously being explored by geochemical methods. The study of radioactive changes is yielding information relating to the origin of certain elements, to geologic time, and even to problems in cosmogony.

45TH ANNUAL MEETING

The 45th annual meeting of the Society was held at the Cosmos Club, December 8, 1937, President R. C. WELLS presiding.

The annual reports of secretaries and treasurer were read and approved.
The Society elected the following officers for 1938:
President: H. D. MISER.
Vice Presidents: J. B. REESIDE and W. P. WOODRING.
Treasurer: A. H. KOSCHMANN.
Secretary: J. W. GREIG.
Members-at-Large-of-the-Council: C. G. BROWN, E. P. HENDERSON, K. E. LOHMAN, A. N. SAYRE, and E. A. TRAGER.

558TH MEETING

The 558th meeting was held at the Cosmos Club January 12, 1938, President H. D. MISER presiding.

Program: L. W. STEPHENSON and W. H. MONROE: *Stratigraphy of the Upper Cretaceous of Mississippi and Alabama.*

A. K. BREWER: *Age of matter as determined by the radioactivity of potassium and rubidium.*—Potassium and rubidium have long been known to emit beta rays. In consequence these elements may be used to determine the age of matter provided the following facts are known: (1) the abundance of the isotopes responsible for the emissivity; (2) the amount of end products formed, and (3) the rates of conversion. It has recently been shown that isotopes $_{19}K^{40}$ and $_{37}Rb^{87}$ are responsible for the entire radioactivity. Mass spectrographic measurements give the ratio of total potassium to K^{40} as 9000, while the ratio of total rubidium to Rb^{87} is 3.59. The end products of the disintegration have been found to be $_{20}Ca^{40}$ and $_{38}Sr^{87}$. The ratios in the earth's crust of the end products to the radioactive isotopes are $Ca^{40}/K^{40}=1.24\times10^{4}$, and $Sr^{87}/Rb^{87}=0.29$.

The radioactive constants for potassium and rubidium have been measured by means of a Geiger Counter, using a thin aluminum window to admit the rays. The disintegration constants so obtained are for K^{40}, $\lambda=9.1\times10^{-10}$ yrs.$^{-1}$ and for Rb^{87}, $\lambda=1.35\times10^{-11}$ yrs.$^{-1}$. These values depend for their accuracy on the absorption coefficients given by Klumperer, Proc. Roy. Soc. **148**: 630. 1935.

An upper limit for the age of matter is given by the time required for K^{40} and Rb^{87} to be increased by the amount of Ca^{40} and Sr^{87} in existence today. This may be computed from the equation $1/N_0=e^{-\lambda t}$, where $N_0=1+Ca^{40}/K^{40}$ and Sr^{87}/Rb^{87}. The values for the age of matter so computed are $K=1.06\times10^{10}$ yrs. and $Rb=1.5\times10^{10}$ yrs.

A. C. SPENCER and K. J. MURATA: *Base exchange as a factor in estimating the age of the ocean.*

559TH MEETING

The 559th meeting was held at the Cosmos Club January 26, 1938, President H. D. MISER presiding.

Program: Symposium on the relation of some volcanoes to geologic structure.

E. G. ZIES: *Santa Maria dome, Guatemala.*—In 1902 a series of violent explosions blew out a crater on the S. W. flank of the supposedly extinct volcano of Santa Maria in Guatemala. Karl Sapper (Neues Jahrbuch f. Min. Geol. Pal. 1904, I, 39) estimated that about 5½ cubic kilometers of clastic material were ejected during the eruption. No further activity was observed until August of 1922 (Sapper, Zeit. f. Vulkanologie IX, 158) when a series of eruptions initiated the building of an andesitic volcanic dome which within a period of about 3 years reached a height of about 900 feet above the present floor of the crater. In 1929 a series of glowing clouds

emerged from the base of the dome. Intense thermal and chemical activity are still in evidence. The carefully recorded history of the dome and its continuing activity provide the student of volcanology with an exceptional opportunity for study.

E. CALLAGHAN: *Volcanoes of the Cascade Range.*

C. S. ROSS: *Valles Volcano, New Mexico.*—The Valles volcanic crater is situated west of Santa Fe, and north of Albuquerque, New Mexico. This is an explosive vent or rather group of vents, that have built up a crater of elliptical shape, about 13 by 17 miles in extent. This makes it the largest crater ever reported. The materials ejected are almost exclusively tuffs which reach a thickness of at least 1,000 feet on the east flank. Paleozoic sedimentary rocks underlie the volcanics on both the north and south flanks, and are also exposed in the crater floor. Thus it occupies a gentle dome, and is not a crater of subsidence. The underlying rocks dip off to the east at about the same rate, but in the Rio Grande canyon 3 to 4 miles farther east no Paleozoics are exposed. Thus a fault zone may lie not far west of the Rio Grande, but from there to the crest of the granite mass about 38 miles farther west, there is no observable faulting.

A. H. KOSCHMANN: *The Relationship of the Cripple Creek Volcano to Regional Structure.*—The Cripple Creek district lies in the central part of Colorado 17 miles in a straight line southwest of Colorado Springs and 9 miles southwest of Pikes Peak. The district consists of a denuded composite volcano which lies on a gently undulating plateau between 9,500 and 11,000 feet in altitude, deeply cut by canyons. The region surrounding this volcano consists chiefly of pre-Cambrian granite capped in places by sandstone, conglomerate and some volcanic rocks.

Structurally the Cripple Creek volcano lies on the southwest end of the Front Range which represents an anticlinal uplift of Laramide age. The Range has been truncated and almost stripped of its cover of Paleozoic and later rocks and consists chiefly of pre-Cambrian rocks excepting small synclinal remnants or graben of sedimentary rocks. Such remnants of sedimentary rocks in the Pikes Peak quadrangle are sufficient to outline the regional structure and show that the Cripple Creek volcano lies on a structural high. Major faults of the area apparently had not had any influence in determining the location of the volcano.

Locally, a group of prominent fractures undoubtedly influenced the immediate location and outline of the volcano. A study of the surface outline of the volcano's neck shows it to be extremely irregular but the influences of prominent pre-volcanic fissures is seen in its angular outlines. Subsequent influence of these fissures is seen in the parallelism of many dikes and veins to the straight stretches of the surface outline of the neck. General vertical uplift during and following the Laramide revolution apparently produced major fissures, in part parallel to pre-Cambrian dike-filled fissures, which thus guided the rising magma and the escaping gases.

W. S. BURBANK: *Silverton caldera, San Juan County, Colorado.*—The Silverton caldera is located in the San Juan Mountains of southwestern Colorado near the western edge of the Tertiary volcanic field that covers an area of over 3,000 square miles in the State of Colorado.

The Silverton volcanic series with which the caldera is associated is one of the older series of the San Juan volcanic field, and is of Miocene age. The series has a maximum thickness of at least 3,000 feet, covers an area of about 1,000 square miles, and has a volume of about 250 cubic miles.

Structurally, the caldera is located near the edges of two ancestral up-

lifts of the San Juan Mountains. The uplift as it now exists was first outlined in late Paleozoic time. After renewal of sedimentation in the Mesozoic, this uplift was rejuvenated and much enlarged during late Cretaceous and early Tertiary time.

The Silverton caldera, which appears to be one of the eruptive centers of the Silverton series, is a downfaulted or collapsed block of volcanic rocks about 8 miles in diameter. The central collapsed block is surrounded by radial fissures and dikes, and by radial and concentric intrusive axes.

As seen in plan, the structure of the caldera presents a remarkable symmetry, not only in the shape of the central collapsed block, but also in the focal concentration of the dikes and fracture systems towards this center. The pattern of this structure obviously is not inherited, but was produced by some igneous bodies acting over a large area of the crust and probably from considerable depth, as otherwise the lack of homogeneity in the shallow crust would have caused greater distortion of the fracture pattern.

The caldera is located on the northwest flank of the compound pre-Tertiary uplift without apparent relation to, or without control inherited from, the structural framework of the pre-Tertiary formations. The fact that the radial intrusive axes extend much farther towards the west than towards the east, and also the fact that the dikes and fissures are much more continuous westward, suggests that the magma lay shallower in the crust in this direction. Hence the magma may have risen obliquely from great depth beneath the more central parts of the San Juan mountain block and migrated toward the plateaus. Finally at a certain critical level the pressure of the magma became sufficient to fracture the overlying crust or to permit invasion by stoping. The flanks of the two ancestral uplifts may have provided zones of weakness or of shearing that assisted in the upward migration of the magma.

This widespread melting of the deep crustal zones was more or less coincident with the continental uplift of the mountain and plateau country as a whole, which was initiated during early Tertiary but which was much accelerated during middle and later Tertiary time. It is interesting to note that throughout the entire range of Paleozoic and Mesozoic time, this region, except for local mountain groups, lay beneath or close to sea level, and that there had been very little igneous activity prior to the end of Cretaceous time.

H. D. MISER: *Volcanoes of the Gulf Coastal plain.*—Volcanoes that were active in Upper Cretaceous time were numerous in the Gulf Coastal Plain. The igneous rocks forming their cones and occupying their necks are found in Texas, Arkansas, Louisiana, and Mississippi. Many of the occurrences of such rocks are exposed and many others have been revealed in deep wells. The known occurrences are confined to a winding belt with arcuate bends extending northeastward from southern Texas into Arkansas and thence southeastward into Louisiana and Mississippi. This belt coincides with the belt of deformed Paleozoic rocks of the Ouachita geosyncline. Although the belt is now largely concealed by Cretaceous and Tertiary rocks, the structural features of the superjacent Cretaceous and Tertiary rocks bear a relation in origin to movement in the basement rocks.

A volcanic cone underlies a part of the Monroe gas field of Louisiana and volcanic rocks underlie the Jackson gas field of Mississippi. The origin of the structural features of the gas-bearing strata in these two areas is probably related to the igneous rocks of Cretaceous age lying underneath them. Igneous rocks—some of them occupying volcanic necks—have been found

in deep wells that have been drilled on geophysical highs elsewhere in Louisiana, Mississippi, and southern Arkansas.

In central and southwestern Arkansas nephelite syenites and many other kinds of igneous rocks are exposed. The diamond-bearing peridotite near Murfreesboro in that State occupies the necks of Upper Cretaceous volcanoes. The character and distribution of water-laid volcanic tuff and ash in the Woodbine and Tokio formations of the Upper Cretaceous in Arkansas, Oklahoma, and Texas indicate that the tuff and ash were derived from old volcanics now concealed in southwestern Arkansas—one near Nashville and another near Lockesburg.

The Chapman and Lytton Springs oil fields, which are here briefly mentioned, are two of the many fields in central Texas yielding oil from serpentine which is altered from volcanic rocks of Upper Cretaceous age. The serpentine in the Chapman field occurs as a flattened ovate mass about one square mile in extent and lies within, but close to the base of, the Taylor marl of Upper Cretaceous age. Presumably the lava that was later transformed to serpentine was extruded on the floor of the Upper Cretaceous sea. The serpentine mass of the Lytton Springs field is an ovate-shaped mass measuring about 9,000 by 9,500 feet. It underlies the Taylor marl and occurs in part in the Austin chalk. A slight structural dome at the surface overlies the serpentine. Presumably the lava and ash later changing to serpentine were erupted into the sea in early Taylor time. The igneous rocks in the Coastal Plain in Texas lie in a belt 200 miles long. They are all of Upper Cretaceous age except some occurrences near Uvalde of Tertiary age. Within this belt is the Balcones fault zone and along its southeast side is the Mexia fault zone in or near which the oil-bearing serpentine occurs. The close correspondence of igneous activity and faulting in the Balcones and Mexia zones shows that a genetic relation exists between them.

The igneous activity in early Upper Cretaceous time in the Gulf Coastal Plain in Texas, Arkansas, Louisiana, and Mississippi was contemporaneous with the initial downwarping of the Mississippi embayment, as well as downwarping elsewhere in the Gulf Coastal Plain. The igneous activity doubtless accompanied deep-seated adjustments in molten material under the subsiding area. The Ouachita belt in which the igneous rocks reached the surface apparently contained zones of structural weakness in the deformed Paleozoic rocks whence the molten and fragmental material could move upward most readily.

Besides the volcanic rocks that have been described above, bentonites derived from volcanic ash are extensive in the Gulf Coastal Plain from Texas to Florida. Some of them are of Upper Cretaceous age and their sources probably have been, at least in part, from the volcanoes here described, but other unexposed centers of the same age may also have contributed pyroclastic materials. Other beds of bentonite occur at many horizons in the Tertiary; their source is not known.

560TH MEETING

The 560th meeting was held at the Cosmos Club February 9, 1938, President H. D. MISER presiding.

Informal communications.—D. G. Thompson drew the attention of the Society to a series of papers on "The Archeology of Pleistocene Lake Mohave" published as number eleven of South West Museum Papers, Los Angeles, describing artifacts suggesting that man had lived along the shores of this lake which was in existence some 15,000 years ago.

Program: V. H. JONES: *Sedimentation in Herrin Reservoir No. 2, Illinois, from 1926 to 1935.*—During a program of reservoir study in Illinois through the summer of 1936, the writer with D. Hoye Eargle of the Section of Sedimentation Studies, had opportunity to visit the drained municipal reservoir of Herrin, Williamson County, Illinois. Since the failure of the dam on June 20, 1935, the lake had been empty and the silt deposits were accessible for measurement and study on May 12 and 13, 1936. Reconstruction of the dam was nearly complete at that time and water was again beginning to accumulate in the basin.

Unusually accurate interpretation of the lake's history was possible because an accumulation of leaves or seeds had been included in each year's deposit. A brief outline of the construction and history of the lake follows.

In February 1926, the earthen dam and concrete spillway were completed and storage of water was begun in the narrow valley of Wolf Creek above the dam. The resulting lake was 12 miles south of Herrin in the west half of Section 20, T. 10 S., R. 2 E., Williamson County, Illinois. The dam was 18.5 feet high with spillway crest at 479 feet above sea level.[1] For 10 years the impounded water of the lake, which was nearly 1 mile long, 1,000 feet wide, and contained an estimated quantity of 350,000,000 gallons at crest level, furnished an adequate supply of water to the city.

Early June of 1935 brought a period of unusually heavy rains which continued for 13 days. On the 20th this was climaxed by a precipitation of 6 inches over the watershed within 6 hours. Overflow water gorged the spillway, and mounted high enough to flow over the top of the dam, and resulting erosion cut through the dam early in the morning of June 21. Although some silt was removed by flushing action of the flood and subsequent escape of the lake water, only a small proportion of the accumulated silt was affected. The small delta, nearly 600 feet long and about 150 feet wide, was completely truncated by reestablishment of Wolf Creek channel through it. At one locality the beds thus revealed tell the complete sedimentary history of the lake.

At and near crest level the delta was more than 200 feet long and ranged from 150 feet in width at the lower end to zero at the head. The deposit had ponded the water of a small tributary. In the lower lake near the dam the sediment had an average thickness of nearly 2 feet which had been compacted an unknown amount by drying. Where the delta deposit was thickest the average yearly deposition was 1.2 feet, measured after a year of exposure to the atmosphere.

L. W. STEPHENSON and J. B. REESIDE, JR.: *A comparison of the Upper Cretaceous deposits of the Gulf region and western interior.*

561ST MEETING

The 561st meeting was held at the Cosmos Club February 23, 1938, President H. D. MISER presiding.

Informal communications.—W. P. WOODRING spoke on the terms *synclinorium* and *anticlinorium.* WALTER E. WARREN read a note on the age of the Guy Formation, Cascade region, State of Washington.

Program: R. E. STEVENS: *The constitution of lepidolite.*

A. F. BUDDINGTON: *Some problems of Adirondack geology of general significance.*—The author is engaged in a general study of the geology of the igneous rocks of the Adirondacks. Three problems of general significance were discussed.

[1] Data given by A. S. Misker, Supt. of Herrin Water Dept.

The anorthosite of the Adirondacks is interpreted as a differentiate of a gabbroic anorthosite magma of a composition consisting of about 80 per cent normative plagioclase ($Ab_{46}An_{54}$), 12 per cent femic molecules and the remainder of salic molecules. This is based in part on the composition of the border facies assumed to represent a relatively undifferentiated facies. The intrusive nature of this magma is based on the local sill structure, associated profound metasomatic replacement skarns of a peculiar and characteristic type, formation of igneous breccias, assimilation and nebulitic structures, etc. The general arrangement of layers in thick gabbroic stratiform sheets was discussed and taken as suggestive of the arrangement of layers in the outer part of the earth. A bytownite anorthosite horizon is therefore postulated to exist somewhere above the peridotite zone. Partial melting of such a calcic anorthosite layer will yield the type of magma postulated. Field evidence indicates a noteworthy volatile content in the magma so that no abnormally high temperatures need be assumed for it.

The major gabbro bodies of the Adirondacks have been variously interpreted as older than the quartz syenite and granites, younger than the quartz syenite and granites, and those within the anorthosite either as intrusive or as early crystal accumulates from a magma of much different composition. The younger age of the gabbros with respect to the granitic rocks has in large part been based on fine-grained border zones. These are now interpreted by the author as "pseudo-chill" zones, a product of contact metamorphic recrystallization by the granite which is younger. The tabular olivine gabbro bodies within the anorthosite have in many cases been proven to be dikes athwart the foliation of the anorthosite and are therefore younger intrusives and not crystal accumulates.

Three-fourths of the igneous rocks of the Adirondacks show a granoblastic structure and evidence is presented that their regional foliation and linear structure are a product of plastic or solid flow. There is a systematic regional variation in the size of grain of similar rocks, and concomitantly a consistent variation in the mineralogic facies developed by reconstitution in each type of rock within different metamorphic zones. In particular, gabbros of the same chemical composition are found to show a regional variation from a hornblende-labradorite facies through a hornblende-augite-hypersthene labradorite type, to rocks consisting of oligoclase, hypersthene, and garnet, or of hornblende, oligoclase, and pyrope-almandite garnet. Hypotheses which assume the foliation and linear structure of the border facies of the anorthosite massif and the surrounding rocks to be a magmatic flow structure are believed by the author to be based on an untenable foundation.

562ND MEETING

The 562nd meeting was held at the Cosmos Club March 9, 1938, President H. D. MISER presiding.

Informal communications.—A. C. SPENCER showed two slides giving in graphic and tabular form the data of the paper on Base exchange. (See regular program January 12, 1938.)

Program: H. G. FERGUSON and S. W. MULLER: *Structural geology of the Hawthorne and Tonopah Quadrangles, Nevada.*

ROLAND W. BROWN: *The Cretaceous-Eocene boundary in Montana and North Dakota.*—The paleontologists who first studied the fossil plants and animals collected from the lignite-bearing strata of western North Dakota and eastern Montana could not agree on a boundary between the Mesozoic and Cenozoic in that area. The paleobotanists held that the Hell Creek strata

with *Triceratops* dinosaurs also carried a flora that was identical with the recognized Fort Union flora and should be classed as Cenozoic. The paleozoologists insisted that not only was the Hell Creek with its dinosaurs Mesozoic but that the overlying marine Cannonball and its continental equivalents, carrying a fauna having a close affinity to preceding Cretaceous faunas, should also be included in the Mesozoic. Evidence accumulated by the speaker during the past eight years of field and office study now shows that some of the early contenders in this boundary dispute were mistaken both as to the distribution of the strata and in the identifications of some important species of fossils involved in this controversy. Carefully measured sections checking and supplementing those given in the coal reports and other publications, together with identifications of new collections of fossil plants and animals from critical points on or adjacent to the disputed boundary, indicate that the strata overlying the Hell Creek formation and underlying the Wasatch constitute a recognizable, measurable, and mappable unit, carrying a distinctive flora and fauna differing significantly from those of the Hell Creek and Wasatch. The *Triceratops dinosaurs*, ammonites, a species of cycad, and some species of dicotyledons, according to the most reliable records from this region, became extinct before or at the close of Hell Creek time. On the other hand, a flora and fauna of distinctly modern cast began to emerge from the body of Cretaceous life at that time. Paleontologists almost universally have accepted the term Paleocene as a period designation of equal rank with Eocene, Oligocene, Miocene, etc., to include the transitional strata here in controversy as well as similarly situated, disputed strata in other parts of the world. In the speaker's opinion the new evidence seconds the acceptance of this practice for it indicates more clearly than ever that the thin zone of interfingering beds at the upper limit of the Hell Creek formation and the base of the immediately overlying Fort Union in its emended sense, marks the boundary between the Mesozoic and the Cenozoic.

EARL INGERSON: *Albite trends in the Piedmont.*

563RD MEETING

The 563rd meeting was held at the Cosmos Club March 23, 1938, President H. D. MISER presiding.

Informal communications.—J. W. GREIG reported that he had made a series of melting experiments on material produced by the melting of overlying beds by a burning coal seam and that the experiments showed that a temperature of about 1,200° had been produced.

Program: MARLAND BILLINGS: *The Geology of western and central New Hampshire.*—Our knowledge of the bed-rock geology of New Hampshire has been greatly increased by investigations carried on during the last ten years by a dozen geologists representing Harvard, Wellesley, Dartmouth, Radcliffe, Brown, Bryn Mawr, and the University of Minnesota. The mapping of about 2,000 square miles has been completed, but less than half the maps have been published.

The metamorphosed sedimentary and volcanic rocks of western and central New Hampshire are dated from a few Silurian and Devonian fossil localities around Littleton, New Hampshire, and Ordovician fossil localities around Montpelier, Vermont. The Ordovician (?) rocks of New Hampshire, 12,000 feet thick, were initially shale, sandstone, and volcanic tuff. The Silurian rocks are composed of an underlying quartzite and quartz conglomerate, 0 to 1,200 feet thick, and an overlying calcareous series from 400 to 700

feet thick. The lower Devonian rocks, originally shale, sandstone, and volcanic tuff, are 5,000 feet thick. These stratified rocks show varying grades of metamorphism, those in westernmost New Hampshire belonging to the low-grade zone or epizone of Grubenmann and Niggli; to the southeast is the middle-grade zone or mesozone; and further southeast is the high-grade zone or katazone.

The stratified rocks are intruded by four magma series: the subalkaline Highlandcroft series, probably late Ordovician; the subalkaline Oliverian magma series, probably late Devonian; the somewhat younger subalkaline New Hampshire magma series, probably late Devonian; and the alkaline White Mountain magma series, probably Mississippian. A recently published lead-uranium ratio seems to confirm the late Devonian age of the New Hampshire magma series. Each of these magma series has its own peculiar mechanism of intrusion. No particular study has been made of the Highlandcroft magma series, but during the late Devonian (?) orogeny these bodies, having consolidated in the late Ordovician (?), behaved as passive plutons. The Oliverian magma series forms large, injected domes, with roofs similar to laccoliths. The New Hampshire magma series occurs as injected, concordant sheets, lenses, and stocks. The White Mountain magma series is in ring-dikes and stocks, the latter presumably having attained their position by some stoping mechanism.

New Hampshire is an unusually favorable state in which to study certain geological features, notably progressive metamorphism, shape of plutonic bodies, relation of plutonic rocks to orogeny and stress conditions in the crust of the earth, and mechanics of intrusion. Moreover, before the Appalachian Highlands are fully understood we must know the geological history of New England and the Piedmont. It is hazardous to speculate on the origin of mountain-built areas without a knowledge of their history.

In addition to the subjects mentioned above, one of the major projects now being pressed is the completion of the mapping of the area between the Ordovician of the Montpelier, Vermont, region and the Carboniferous along the Atlantic coast at Portsmouth, New Hampshire. A second project being actively pursued is the tracing of the Silurian of western New Hampshire southward to Massachusetts and northeasterly to Maine.

R. W. STONE: *Some problems in geology in Pennsylvania.*

564TH MEETING

The 564th meeting was held at the Cosmos Club April 13, 1938, President H. D. MISER presiding.

Program: J. B. MERTIE, JR.: *Platinum placers of the Goodnews Bay district, Alaska.*

R. W. GORANSON: *Silicate-water systems: orthoclase-water and albite-water equilibrium relations.*

OLIVER BOWLES: *Geologic and economic problems of the asbestos industry.*

565TH MEETING

The 565th meeting was held at the Cosmos Club April 27, 1938, President H. D. MISER presiding.

The Standing Rules were amended to read as follows:

Sec. 2. *Officers:*—Last sentence—"In his absence the Treasurer, with the approval of the President, is authorized to appoint an Acting-treasurer."

Sec. 3. *Dues:*—Last sentence, first paragraph—"Any member, whether active or corresponding, who has been a member in good standing for at

least ten years and has been retired from service shall no longer pay dues."

Program: A. I. LEVORSEN: *Some new trends in petroleum geology.*—The dominant geological methods used in the past in the search for new oil and gas pools are: (a) Surface structural mapping, which reached its peak application between 1920 and 1925 and as its use declined, it was replaced by (b) Subsurface structural mapping, which reached its peak application among petroleum geologists between 1925 and 1930. This method was gradually replaced by (c) Geophysical structural mapping (chiefly seismic and gravity) which reached its peak application during 1935 to 1937 and is now declining in importance. The decline in importance of each of these methods has not been due to failure of the method itself but rather to the fact that the field within which each method has been applied became exhausted.

Beginning with 1925 there has been a steady growth in the importance of well cutting examination until at present probably half of the effort of petroleum geologists is given to some phase of sample work. Heretofore the application of this type of geology has been chiefly for structural and production information, but there is evidence that future geological methods of oil finding will be more closely identified with samples and the stratigraphic information which they reveal.

Three trends seem evident in the thought of petroleum geologists as to the future methods which will be used. They are: (1) The changed thought as a result of what might be termed "layer cake" geology—that is the superposition of different layers of geology, each independent of the other and each with its own significance with respect to oil and gas accumulation. Much of our past production is from such an environment and its appreciation definitely increases the values given to new areas where the shallow geology is uninteresting from an oil standpoint.

(2) The rapid development of portable drilling outfits capable of drilling holes to 3,000 and 4,000 feet at a fraction of the previous costs has given petroleum geologists the effect of a new tool. These rigs open up to the geologist and wild-catter tremendous possibilities, particularly in the field of production from sand lenses, shoestring sands, overlaps, and porosity changes.

(3) Since the production in many of the present oil and gas provinces is found to occur at or in the vicinity of changes from porosity to non-porosity within the reservoir rock, it would appear that this phenomenon may be a critical factor in history of the province. There are many such areas of porosity edge yet almost wholly unexplored in the United States and the trend towards cheap drilling opens such areas up for exploration.

W. B. HEROY: *Objectives of research in petroleum geology.*

J. W. GREIG, *Secretary*